

POWER *notes*

PROGRAM ON WORKABLE ENERGY REGULATION

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POWER

BRINGS TOP RESEARCHERS TOGETHER FOR 2ND ANNUAL CONFERENCE ON ELECTRICITY INDUSTRY RESTRUCTURING


On March 18th, 1997 POWER held its second annual research conference on electricity industry restructuring in Berkeley. The program, sponsored by PacifiCorp, Pacific Gas & Electric, Putnam Hayes & Bartlett, Southern California Edison, and the Southern California Gas Company, featured many of the most influential academic and regulatory voices currently active in the industry. *POWER's 3rd annual electricity restructuring conference will be held on March 20, 1998.*

The first session of the day focused on market power issues. **William Hogan** of Harvard University presented an analysis of strategic electricity producers that interact in transmission network with loop flows. The physical aspects of transmission networks allow for unconventional opportunities for the exercise of horizontal market power. Hogan demonstrated a scenario in which a firm with market power can profit from increasing, rather than decreasing, its production at strategic points in the network. UCEI's **Severin Borenstein** (also of the Berkeley Haas School of Business) then presented an empirical analysis (co-authored with UCEI's **Jim Bushnell**) of the potential for market power in California's forthcoming deregulated electricity market. They find that under the existing ownership structure of power plants in the western U.S., there is a significant potential for market power in California during many high-demand periods of the late fall and early winter. The proposed divestitures of power plants by California utilities could significantly reduce market power in the study, according to their work. The flow capacity of certain critical transmission paths, and the elasticity of demand for electricity also have a critical influence on the potential for market power. These papers were discussed by UC Berkeley's **Shmuel Oren** and **Paul Joskow** of MIT. *(continued on next page)*



Paul Joskow, MIT

RESEARCHERS ADD POWER TO THE PX BOARDROOM

In May this year, Severin Borenstein and Carl Blumstein were appointed by the state legislature to serve on the Governing Board of the newly formed California Power Exchange Corporation. The Power Exchange (or PX) is a non-profit organization with a mandate to establish an efficient market for spot and forward electricity transactions in the deregulated California market. The PX and the deregulated market are scheduled to begin operation on January 1, 1998. Blumstein is serving as one of the members from public interest groups and Borenstein is one of the Board's two members that are not affiliated with market participants. 

The second session featured two studies of the electricity market in the United Kingdom. **Catherine Wolfram** of Harvard university presented an econometric analysis of the bidding strategies of the generation companies in the U.K. She examines how bidders with broad portfolios of generation units may mark-up the price of those units in an electricity auction. **Richard Green** of Cambridge argued that long-term contracts play a significant role in reducing the incentives of the dominant producers in the U.K. to exercise market power. Commissioner **Michal Moore** of the California Energy Commission discussed the applicability of these results to the forthcoming California market.



(left to right) *Richard Green, Cambridge, Catherine Wolfram and William Hogan, Harvard*

Stanford University's **Frank Wolak**, also a visitor to UCEI during 1997, kicked off the afternoon sessions with a study (co-authored with Rutgers' **Robert Patrick**) of customer responses to real-time prices in the United Kingdom. Wolak and Patrick find that real-time pricing customers show little reaction to price changes, a somewhat surprising result given that these customers voluntarily chose to participate in the real-time pricing program. **David Newbery** of Cambridge expressed his admiration for both the technical accomplish-



Richard O'Neil, FERC

ments of the study and the significant practical value that such information can provide.

The final, and perhaps most lively, session of the day focused on the design of California's forthcoming electricity spot market. Stanford University's **Robert Wilson**, one of the principal architects of the California Power Exchange's (PX) auction protocols, discussed the challenges inherent in implementing an auction-based spot market in electricity



*Robert Wilson
Stanford University*

and the bidder activity rules designed to meet those challenges. **Raymond Johnson** of Pacific Gas & Electric presented a paper (co-authored with **Alva Svoboda** of PG&E) that studies the interaction between the many types of costs associated with operating a generation unit and the auction protocols used for finding a market price for the production of that unit. In the paper that followed, UCEI's **Steve Stoft** then asked the question "what should a power marketer want?" Stoft observes that power marketers will in many ways be competitors with the formal, institutionalized, California spot market.

Power marketers would therefore not be disappointed if the formal spot market does not succeed. Stoft's concern is that the many restrictions placed upon the California PX by a consensus building design process have put the PX in just such a disadvantageous position relative to power marketers. These papers were then discussed by FERC's Richard O'Neil and Larry Ruff of Putnam, Hayes & Bartlett. 🌐

EDITORS

Severin Borenstein and James Bushnell

PRODUCTION EDITOR AND DESIGNER

Carol Kozlowski, UCEI

PRODUCTION

Inkworks

If you would like to be placed on our mailing list or contribute letters to the editor, please contact POWER at: ckozlow@uclink2.berkeley.edu

or

Program on Workable Energy Regulation
University of California Energy Institute
University of California, Berkeley
2539 Channing Way #5180
Berkeley, CA 94720-5180

POWER notes is published during the academic year to disseminate information about the research activities of POWER.

Severin Borenstein,
Director of POWER
and the University of California
Energy Institute

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POWER Moves

Chris Knittel is the UCEI's newest Graduate Student Researcher, joining UCEI during the Summer of 1996. Chris is a second year Ph.D. student in the department of economics at UC Berkeley specializing in Industrial Organization and Econometrics. Prior to UC Berkeley, Chris received his M.A. in economics from UC Davis, and his B.A. in economics and political science from CSU Stanislaus. Christopher is currently studying the beginnings of state electricity regulation in the United



States (PWP-048) and the motives behind mergers in the U.S. electricity industry. Knittel's previous research has focused on competition in the telecommunications industry. His work in this field has appeared in the *Review of Industrial Organization* and *Utilities Policy*.

POWER is pleased to announce that Graduate Research Assistant **Wedad Elmagraby**, a fifth year Ph.D. student in the department of Operations Research, was awarded the UC Dissertation Year Fellowship. The UC Fellowship is awarded to 12 minority and women graduate students nearing the completion of their dissertation. As a result of this award, Wedad is taking a one-year sabbatical from her R.A. position but will continue to be involved with POWER activities. Her research focuses on the efficiency of electricity auctions when bidders have nonlinear costs.



The fellowship will allow Wedad to concentrate on completing her dissertation as she prepares for this year's academic job market.

POWER Losses

Steve Stoft, a POWER research associate, has taken leave from UCEI to accept a post at the Federal Energy Regulatory Commission's Office of Economic Policy as a Staff Economist. Stoft has been at the forefront of electricity restructuring authoring a variety of papers on markets for transmission rights, transmission constraints and their impact on market power, and investment decisions under a deregulated market.



POWER ANNOUNCES A CALL FOR PAPERS

FOR ITS THIRD ANNUAL RESEARCH CONFERENCE ON ELECTRICITY INDUSTRY RESTRUCTURING



POWER invites interested researchers to submit papers for a one day conference to be held in Berkeley on March 20, 1998. The purpose is to bring together outstanding scholars from around the country to exchange ideas and research results on topics related to electricity industry restructuring.

Papers are invited on any relevant analytic question associated with electricity industry restructuring including, but not limited to, the following subjects:

- Transmission access
- Stranded cost recovery
- Conservation, R&D, and low income programs after restructuring
- Market power
- Operation of wholesale and retail electricity market
- Political economy of restructuring
- International comparisons
- Future role of regulation in electricity

Draft papers should be sent by December 10, 1997 to:

POWER Research Conference
University of California Energy Institute
2539 Channing Way #5180
Berkeley, CA 94720-5180

Authors will be notified concerning acceptance for the conference by January 15, 1998.

Final papers will be due by February 15, 1998.

Please address inquiries to:
Severin Borenstein (510) 642-9588
email address: borenste@haas.berkeley.edu
James Bushnell (510) 642-9588
email address: jimb@cimsim.ieor.berkeley.edu

POWER Losses *(continued)*

Former UCEI Research Assistant, **Haru Connolly** recently accepted a post as Staff Economist at the Department of Justice. Haru recently received her Ph.D. in economics from UC Berkeley. Haru's dissertation explores the impact of research and development on productivity and efficiency in U.S. investor-owned electric utilities, as well as the factors, including utility characteristics and regulation, which affect the choice of research



and development spending by utilities. Her findings indicate that research and development has a small positive effect on productivity, lower research and development spending leads to lower technical efficiency, and regulation that is less friendly to shareholders leads to lower levels of research and development spending.

POWER Visitors


POWER has been very fortunate in having distinguished scholars visiting UCEI recently.

Frank Wolak of Stanford University visited POWER during the 1996-1997 academic year. While at UCEI Wolak performed extensive research on electricity markets in the UK and other countries. His work has culminated in POWER Working Papers 047, (joint with Robert Patrick of Rutgers University) a study of market power in the



UK, and PWP- 051, an international comparison of institutional structures and its impact on market power.

During the Spring of 1998, **Richard Green** of Cambridge University will be visiting UCEI.

Green is widely recognized as an expert on electricity restructuring in the UK. Along with David Newbery, also of Cambridge University, Green was the first to utilize supply function equilibria in estimating the potential for market power in a restructured electricity market. 



Energy Institute focuses on Market Power


The POWER program at the U.C. Energy Institute is continuing to expand its research efforts on the critical topic of electricity industry market power. Interest in this topic continues to grow as plans to deregulate and restructure the electricity industry proceed in many regions of the U.S. and in other countries. Researchers in the POWER program have been studying the issue of market power in the forthcoming California electricity market for some time (see PWP-036, PWP-044). More recently, the scope of this research has expanded to include a broader set of issues and to examine regions outside of California.

Much recent research has examined the impact of electricity transmission capacity, and the methods for pricing it, on the competitive



Jim Bushnell, Associate Director of POWER

health of local and regional electricity markets (see PWP-040, PWP-041, and PWP-049). Other work has examined the role of market rules in determining competitive outcomes (see PWP-047, and PWP-053), and addressed issues of institutional design (PWP-042). While much of the research involves applications to the California restructuring process, other work examines electricity markets around the world (see PWP-047, PWP-051, PWP-052).

POWER will continue to expand the scope of its market power research. Some current projects are looking at the impact of hydro-electric resources on electricity industry competition, with particular focus on the western U.S. market. POWER researchers are also developing models of some electricity markets in the eastern U.S. In addition, POWER will continue to work with California policymakers on this issue as the California market approaches its planned start date of January 1, 1998. 

With the advent of electricity industry restructuring, many investor owned utilities are dramatically revising the role of research and development (R&D) within the deregulated firm. Pacific Gas & Electric and Southern California Edison together spent over \$ 120 million on R&D in 1994. By 1995, after the CPUC issued its initial order proposing to increase competition in the electric industry by restructuring, R&D spending by these firms had dropped to about \$ 62 million. While there are differing views about how much should and will be invested in R&D after restructuring, most agree that there will be few clear incentives for deregulated firms to invest extensively in R&D that has benefits that are non-proprietary and largely external to the firm.

In light of this, California's electricity restructuring legislation (AB 1890) has provided \$62.5 million/year for 1998 through 2001 for "public interest" R&D. The CPUC and the Legislature had concluded that there was a body of important *R&D that would not be adequately provided for by the competitive market since some or all of its benefits would be widely distributed and could not be captured by individual companies*. What will this short definition of public interest R&D mean in practice? The Legislature has given the task of operationalizing the definition to the California Energy Commission (CEC). Among the areas where the benefits of public-interest R&D may be important are health, safety, environment, energy efficiency, and "pre-commercial" technical information. Many R&D projects have both private and public benefits. Some examples will help to clarify what kinds of R&D might be classified as public-interest R&D. These examples are arranged roughly in order of increasing private benefit relative to public benefit. The R&D described in each of the examples has received substantial utility funding, with the costs usually passed through to ratepayers. Significant federal funding has also supported the R&D in all of the examples and private funding has supported the development of commercial products. Sometimes the classification of a project as public-interest R&D is subjective, depending on how one judges the balance between public benefits and incentives for private investment. The reader should decide for herself if all the examples given here can properly be classified as public-interest R&D.

Example 1: Combustion Science

Fundamental studies of combustion are being undertaken to learn more about the processes by which nitrogen oxides (NO_x) are formed in practical burners. One purpose of these fundamental studies is to develop information to guide the design of future high-performance burners. The design objective is ultra-low- NO_x emission without sacrificing combustion efficiency, combustion stability, or turn-down capability. Because NO_x formation in practical burners is very complex, manufacturers have relied to date on empirical, "cut-and-try" methods to obtain improved performance. While this approach has had some success, further gains will require an understanding of the processes by which NO_x is formed and overall performance is maintained. Sufficient progress has been made in the fundamental studies for some new burner designs to be based on scientific theory developed by combustion researchers and there is hope that this approach will lead to a new generation of ultra-low- NO_x burners. For the most part, results from fundamental studies of combustion cannot be appropriated by the sponsor of the research. Usually, they are published in the open literature.

In this example the result of the research is a pure "public good." By this we mean a good that is free and has the property that one person's use of the good does not impair its use by another person. Note that we are using the term "public good" here in a technical sense, as an economist would define it. We use the term "public benefit" when we want to talk in a more general sense about things that are good for the public. Information that is in the public domain is an example of a public good.

Example 2: Residential Heating and Cooling Ducts

Research in the early 1990s showed that residential ducts—the tubes in the attic, crawl space, or basement that circulate air between the heater or air conditioner and the living space—were a major source of energy waste. Typically about one third of the energy that flows through residential ducts is lost through leaks. This loss is estimated to cost US homeowners several billion dollars annually. Because the research established that residential ducts leak and made that information widely available, efforts are underway around the country to find methods for fixing the problem in existing housing and preventing it in new construction. The research created commercial opportunities: new technologies for sealing ducts are beginning to reach the market. However, it seems highly unlikely that any private party would have undertaken to create these opportunities by measuring the performance of ducts and making the results available to the public.

The research in this example also produces a pure public good. However, this research is much more near-term and applied than combustion science. "Long-term" and "fundamental" are not necessary characteristics of public-interest R&D.

Example 3: Venting Technology

Conventional gas furnaces provided trouble-free venting when used in residences because relatively high temperatures made the flue gas buoyant. To increase efficiency and comply with new federal standards, fan-assisted gas furnaces were developed that have lower flue-gas temperatures, reduced air flow, and combustion fans instead of draft hoods. These changes increased the risk of condensation in venting systems designed for conventional atmospheric furnaces. Condensation can cause corrosion and premature failure of the venting system. Research efforts lead to the development of new venting guidelines to meet residential space heating needs.

The venting guidelines produced by the research in this example are a public good. The creation of guidelines and standards also can provide immediate private benefits. By giving consumers assurance regarding safety and reliability, guidelines and standards help to create markets for new products. Compliance with guidelines and standards can reduce the liability exposure of manufacturers and contractors.

Example 4: Solid State Invertors

The ability to convert direct current into alternating current is a key “enabling technology.” By enabling technology we mean technology that makes it possible to accomplish a number of different technical ends. For example, photovoltaic cells and fuel cells both produce direct current that must be converted to alternating current for most uses. Many variable speed drives for electric motors also require conversion of direct current to alternating current. Solid-state invertors are one device for accomplishing this conversion. R&D during the past 15 years has substantially reduced the cost and improved the efficiency of these devices. Efforts to improve these devices are continuing. This R&D has had direct private benefits for firms engaged in the production of solid-state invertors. However, these firms can capture only a small fraction of the benefits from the technologies that are enabled by these devices. Most of the benefit spills over to other firms and to the public at large.

In this example the benefit of the R&D to the public comes from the fact that better, cheaper private goods are becoming available. Of course, this might be said of most R&D that was aimed at developing new products. In these cases one must decide if the R&D is public-interest R&D or if it is R&D that will be adequately provided by the competitive market. In practice this question has often proved difficult. A judgment call must be made: is the public benefit “large enough” and are the private incentives “too small?” The case for classification as public-interest R&D is easier to make when an enabling technology is involved because the potential for spill-over benefits is large.

Example 5: Biopulping

Paper is made by a process that converts wood into a pulp. Pulping is an energy and chemically intensive process. Over the past decade, private research with some federal assistance yielded the promising prospect that common fungi could be used to partially decompose wood ahead of the pulping process, saving significant costs in terms of energy, chemicals, and environmental impacts. In spite of this promise, the consortium working on this technology was unwilling to fund the next stage of development, a mill trial of the technology. At this point, because of the potential public benefits, ratepayer funds were made available to the consortium and a mill trial was initiated. Mill trial results to date have proven very promising. The commercial success of the technology is not yet certain, but private interest has been rekindled and prospects are encouraging. If commercial success is achieved, paper production costs and environmental costs will be decreased. Commercial success will also generate licensing revenues that will be shared, with some going to future public-interest R&D.

In this example a primary public benefit is the large spill-over benefit that results from reduced environmental impacts. In addition, for regions where paper making is important, biopulping may contribute to the economic health of the region. This example also illustrates how arrangements, such as royalty sharing, can be made for the public to participate in the private benefits produced by an R&D project.

While California has taken the lead in providing for public-interest R&D, the issue is also receiving attention in other states and at the federal level. Because the boundary between public-interest R&D and R&D that will be adequately provided by the competitive market depends in part on subjective criteria, it is unlikely that the issues addressed here will be resolved by a universally accepted definition that separates the types of R&D with a bright line. In the rest of the US, as in California, the definition of public-interest R&D is going to depend on the mechanisms used to implement public-interest R&D programs. Strategies for implementing public-interest R&D are a subject of continuing study at the Energy Institute.

POWER WORKING PAPER ABSTRACTS

Most POWER working papers are now available on the Energy Institute website:

<http://www-ucenergy.eecs.berkeley.edu/ucenergy/>
Working papers are posted in PDF format for viewing and printing with Adobe's Acrobat Reader. Acrobat reader is available at no charge from Adobe's website:
<http://www.adobe.com>.

PWP-041

Preemption of TCCs and Deadweight Loss in Centrally Dispatched Electric Systems with Competitive Generation
by Shmuel Oren (UC Berkeley)

The main thesis of PWP-041 is that Transmission Congestion Contracts (TCCs) that are compensated ex-post based on nodal prices resulting from optimal dispatch by an ISO will be preempted by the strategic bidding of the generators. Thus, even when generation is competitive, rational expectations of congestion will enable generators to raise their bids above marginal costs and capture the congestion rents leaving the TCCs uncompensated. These conclusion is based on a Cournot model of competition across congested transmission links where an ISO dispatches generators optimally based on bid prices.

First, Oren considers the case of one demand bus characterized by an elastic demand curve separated by a congested transmission link from a supply bus with many identical generators. Unlike the standard Cournot oligopoly result where prices converge to marginal cost as the number of suppliers increase, here the equilibrium prices converge to the demand price corresponding to the congested supply quantity. Thus, the generators capture all the congestion rent and the TCC for the link remains uncompensated. In a second example with two supply nodes of different marginal costs the equilibrium price at all nodes converges to the higher of the marginal cost so that the generators at the cheaper node captures all the congestion rent. The price distortion in the three node Cournot equilibrium results in a deadweight loss. Oren concludes that efficient dispatch requires active trading of Transmission Capacity Reservations. Supplanting such trading with passive TCCs that are compensated ex-post by the ISO based on the energy market outcome creates undesirable market power for the generators.

PWP-042

Analysis of the California WEPEX Applications to FERC
by Steven Stoft (UCEI and LBNL)

The major theme of this report is that the WEPEX Applications prevent the ISO from clearing the market, and that this

is the root of the most important problems. The rules at fault (1) prevent the PX and other Scheduling Coordinators from passing on all of their bids to the ISO, and (2) prevent the ISO from dispatching beyond the point at which congestion is eliminated. Although it is generally accepted that these restrictions prevent the ISO from achieving the least-cost dispatch, many other consequences of this market-clearing failure have not been widely recognized. These include sub-optimal dispatches by the PX when the system is uncongested, congestion charges that reward power flow in the congested direction, and incentives for Scheduling Coordinators to ignore known intra-zone congestion. But the most pernicious effect of failing to clear the market may be decreased system reliability. Only two changes are necessary to remedy these problems: (1) allow the Scheduling Coordinators to submit all of their bids to the ISO; and (2) allow the ISO to minimize cost using all submitted bids. Four minor themes will also be considered. First, and most important, is the lack of even-handed treatment of the PX. Second is the ambiguity introduced by a definition of zonal pricing that ignores loop flow. An alternative definition is offered. Third, the WEPEX definition of transmission congestion contracts (TCCs) is based on actual instead of pre-specified flows which spoil the incentive properties of TCCs. Lastly, the WEPEX proposal intentionally avoids marginal-cost pricing of losses. This cause some inefficiency, but more significantly, increases use of the power grid which will necessitate costly grid expansion. These problems can be solved by basing zone definitions on differences in marginal cost, by using the standard TCC definition, and by using marginal-cost pricing of losses.

PWP-043

The Introduction of Direct Access in New Zealand's Electricity Market
by Mario E. Bergara and Pablo T. Spiller (UC Berkeley)

New Zealand introduced completely deregulated direct access in 1994. In this paper Bergara and Spiller provide the first assessment of one full year of direct access. They explore the determinants of direct access penetration across all the operating distribution companies. The authors find that the penetration of direct access in New Zealand responded quite clearly to economic incentives: companies that had unbalanced rates, that had high direct costs, that had high utilization rates, that had low load factors and low frequency of system interruptions had, on average, much higher rates of direct access penetration. These results took place even though this analysis is confined to the first year of operation, and in an environment in which the terms and conditions for direct access are negotiated between the distribution company and each individual direct access competitor. Thus, they suggest, that much of the current emphasis in the US in regulating terms and conditions of direct access is misplaced.

PWP-044*An Empirical Analysis of the Potential for Market Power in a Deregulated California Electricity Market*

by Severin Borenstein (UC Berkeley and UCEI) and James Bushnell (UCEI)

In PWP-044, Borenstein and Bushnell use a market simulation approach to examine the potential for market power in a restructured California electricity market. They use historical data on plant costs and capacities to simulate a deregulated market for electricity in California following restructuring. While it is important to recognize the limits of a static competitive model such as this, approach still provides useful insight into the workings of markets and the factors that may have the greatest influence on the exercise of market power. Their model indicates that, under the current structure of generation ownership, there is potential for significant market power in high demand hours. The most severe problems arise in the fall and early winter months when hydroelectric output is at its lowest level relative to demand in both California and the pacific northwest.

The simulation results also show that two of the most important factors in determining the extent and severity of market power are the levels of available hydroelectric production and the elasticity of demand. In fact, these factors have a greater impact on equilibrium prices than the proposed divestitures of California's largest producers. It is important for policy makers to recognize that the elasticities of both supply and demand are not completely exogenous factors. These results indicate that policies that promote the responsiveness of both consumers and producers of electricity to short-run price fluctuations can have a significant effect on reducing the market power problem. Such policies may be more rewarding, and face less resistance, than remedies that rely on structural changes to the industry or direct intervention in price setting.

PWP - 045*Price Driven Coordination in a Lossy Power Grid*

by C. Bart McGuire (UC Berkeley GSPP and UCEI)

In a lossy electric power grid complex interactions exist among the decisions of power producers, power consumers, and the operator of the transmission grid. Must coordination be carried out centrally, or can some form of decentralization achieve an equally good result? In particular, can price-quantity dialogues between producers and consumers on the one hand and power grid managers on the other provide sufficient dissemination of information to achieve an economically efficient outcome? McGuire examines this question in the context of a simple DC lossy system with rather simply characterized producers and consumers. An effective iterative price-quantity adjustment process is proposed and demonstrated in a simulation model. Decision interactions (i.e., externalities) are carefully specified and internalized in the economist's tra-

ditional way by imposition of transmission tolls. Emphasis is placed on the use of prices to drive - not merely reflect - socially good decisions.

PWP-046*Solving Unit Commitment by a Unit Decommitment Method*

by Chung-Li Tseng (Edison Source), Chao-an Li (Edison Source), and Shmuel S. Oren (UC Berkeley)

In PWP-046, Tseng, Li, and Oren present an efficient and robust method for solving unit commitment problems using a unit decommitment method.

PWP-047*The Impact of Market Rules and Market Structure on the Price Determination Process in the England and Wales Electricity Market*

by Frank A. Wolak (Stanford and UCEI) and Robert H. Patrick (Rutgers)

In PWP-047, Wolak and Patrick argue that the market rules governing the operation of the England and Wales electricity market in combination with the structure of this market presents the two major generators-National Power and PowerGen-with opportunities to earn revenues substantially in excess of their costs of production for short periods of time. Generators competing to serve this market have two strategic weapons at their disposal: (1) the price bid for each generation set and (2) the capacity of each generation set made available to supply the market each half-hour period during the day. The authors argue that because of the rules governing the price determination process in this market, by the strategic use of capacity availability declarations, when conditions exogenous to the behavior of the two major generators favor it, these two generators are able to obtain prices for their output substantially in excess of their marginal costs of generation. By analyzing four fiscal years of actual market prices, quantities and generator bids into the market, they provide various pieces of evidence in favor of the strategic use of the market rules by the two major participants. The paper closes with a discussion of the lessons that the England and Wales experience can provide for the design of competitive power markets in the US, particularly California, and other countries.

PWP-048*The Origins of State Electricity Regulation: Revisiting an Unsettled Topic*

by Christopher R. Knittel (UC Berkeley and UCEI)

In PWP-048, Knittel analyzes the impetus for the growth of state regulation beginning in 1907. Although the growth in electricity use during the turn of the century was a major factor in the growth of the US economy historians and economists have left a number of issues regarding the regulation of the industry unsettled. Knittel attempts to reconcile some of these issues. Specifically, the paper tests the validity of the

three most commonly forwarded reasons for the origin of state regulation in the electricity industry. Using Census data gathered on the electricity industry, the paper concludes that state commissions acted in the interest of the public, while seeking to exploit the economies of scale that existed in the industry. The paper also draws on the work of Anderson (1981) in looking at documents from the National Electric Light Association to gauge the industry's mindset during this period and concludes that industry leaders supported state regulation in order to rid themselves of corrupt local politicians, but did not uniformly support all regulation as is commonly believed.

PWP-049

How Financial Transmission Rights Curb Market Power
by Steven Stoft (UCEI and LBNL)

This paper demonstrates that financial transmission rights allow their owners to capture at least a portion, and sometimes all, of the congestion rents. This extends work in this area by Shmuel Oren which was limited to the case in which generators could not purchase financial transmission rights. One form of financial rights, Transmission Congestion Contracts (TCCs), is shown to be so effective in reducing market power that as few as two generators facing a demand curve with zero elasticity may be forced to sell at marginal cost. The extent to which market power is limited depends on the extent to which total generation capacity exceeds export capacity and on the size of individual generators. A relationship is derived that determines when TCCs will eliminate market power. In the case of a three line network, it is shown that the reduction in market power that can be accomplished with "active transmission rights" can also be accomplished with simple contracts for differences.

PWP-050

Optimal Power Flow Node Prices, and Transmission Tolls In a Number of Instructive Examples by C. Bart McGuire (UCEI and Graduate School of Public Policy UCB)

A theory of optimal real and reactive power flow, node prices, and transmission tolls suited to decentralized operation of a power grid is explored in the context of various numerical examples. A simple OPF program REX is described. With a view toward achieving an understanding what an economic network would be, values of various grid components are calculated and compared to the corresponding toll revenues generated. Further REX-addressable questions are invited.

PWP-051

Market Design and Price Behavior in Restructured Electricity Markets: An International Comparison
by Frank Wolak (Stanford University and UCEI)

This paper argues that the market rules governing the operation of a re-structured electricity market in combination with

its market structure can have a substantial impact on the ability of participants in the market to exercise market power. Using evidence on the design of electricity markets in England and Wales, Norway, the state of Victoria in Australia and New Zealand, this paper illustrates that market structure and market rules are important drivers of the behavior of prices in a competitive electricity market. The paper first summarizes the important features of the market structure and market rules in each country. Then it proceeds to provide an assessment of the relationship between market rules and market structure and the behavior of prices in each market. The paper closes with a short discussion of the evidence that the behavior of prices in each country is the result of the exercise of market power.


PWP-052

Political Institutions and Electricity Utility Investment: A Cross Nation Analysis by M.E. Bergara, W.J. Heinz, and P.T. Spiller (U.C. Berkeley)

The likelihood that a government will meet its promises varies with the structure of a nation's political institutions. Where multiple independent actors wield veto power over potential policy changes, macroeconomic, tax and regulatory stability will be enhanced thus reducing the variance on an investment project's expected return. This relationship is shown to hold for an industry with extremely high sunk costs and politicization: electric utilities. Managers considering investment in infrastructure projects should therefore evaluate the investment proposal not only on its explicit terms but also on the likelihood that the government will honor them.

PWP-053

Multi-Unit Auctions with Dependent Valuations: Issues of Efficiency in Electricity Auctions
by Wedad Elmaghraby (UC Berkeley and UCEI)

As auction based mechanisms for electricity dispatch are emerging in previously regulated Electricity Supply Industries, it is imperative to understand the effect of auction rules and structure on efficiency. Elmaghraby addresses this relationship by asking what auction structure are sufficient to guarantee that demand is satisfied in a least-cost manner. What makes this an interesting and challenging question is the existence of electricity industry-specific characteristics such as 1) the existence of start-up costs, 2) the desire of generators to supply several MWh of demand, 3) the cost dependencies in supplying MWh in both time and quantity dimensions, and 4) the inability to store electricity. Using a complete information framework, Elmaghraby finds that any auction that uses a uniform pricing rule in a multi-unit environment with strictly concave costs will not be able to guarantee efficiency in equilibrium. In order to guarantee efficiency, it is both necessary and sufficient to use a discriminatory price auction with the simultaneous auction of all demand lots. 

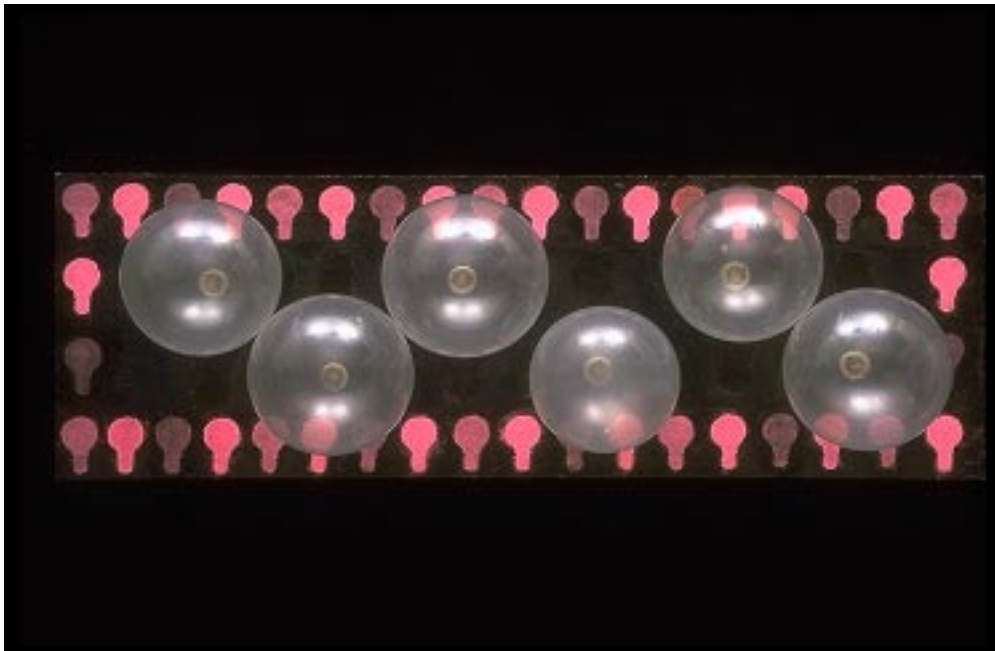
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University of California, Berkeley
University of California Energy Institute
2539 Channing Way #5180
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